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SOME AUSTRALIAN LATE CAINOZOIC ECHINOIDS

By R. J. Foster* and G. M. Philip**

Abstract: Late Cainozoic echinoids described and illustrated from various localities in Western Australia, South Australia and Victoria include the living species *Amblypneustes formosus* Valenciennes, *Microcyphus annulatus* Mortensen and *Peronella orbicularis* (Leske). The Pliocene species *Arachnoides incisa* Tate is referred to *Fellaster* and is recorded from the Werrikooian of Victoria. *Amblypneustes* sp. nov. occurs in the ?early Pleistocene Roe Calcarenite of Western Australia. These records indicate the replacement of the diverse older Cainozoic echinoid fauna with some modern forms from the Pliocene onwards.

This paper describes available echinoids from various Pliocene and Pleistocene localities in Western Australia, South Australia and Victoria and represented in various museums. Although only temnopleurids and clypeasteroids are present in the material so far discovered, it is judged to be sufficiently representative to justify general observations on the fauna.

The widespread mid-Tertiary bryozoal lime grainstones of southern Australia contain a remarkably prolific and characteristic echinoid fauna which bears little close comparison with the Australian echinoid fauna of today if cosmopolitan spatangoids such as *Schizaster* are excluded from consideration. By late Pliocene times marine sedimentation was far more restricted and usually of a clastic character. Echinoids recovered from these late Tertiary strata are few in number, but are modern in their relationships. Although some characteristic living Australian genera appear first in the Oligocene or early Miocene (e.g. *Phyllacanthus*, Philip 1963, p. 202; *Goniocidaris*, Philip 1964, p. 449; *Heliocidaris*, Philip 1965, p. 191), from the available record it appears as if the mid-Tertiary fauna was largely replaced in the late Miocene and Pliocene, and by the early Pleistocene the modern fauna was fully established. *Pseudechinus* appeared in the late Miocene as did the characteristic living littoral New Zealand genus *Evechinus* (Philip 1969, p. 233, p. 268). The early Pliocene saw the appearance of *Fellaster* with the species *F. incisa* (Tate) which extends upwards into the early Pleistocene. The mid Pliocene Hallett Cave Sandstone contains the species *Goniocidaris tubaria hallettensis* Philip, a subspecies of the living form, together with *Peronella platymodes* (Tate) which is probably a forerunner of the living species *Peronella orbicularis* (Leske). By the Pleistocene this latter species had appeared, together with the living temnopleurids *Amblypneustes formosus* Valenciennes and *Microcyphus annulatus* Mortensen. These temnopleurids belong to the group with pitted sutures; all of the older temnopleurids are sculptured.

This incomplete record seems to indicate that although the origin of some components is in the older Tertiary faunas, the living echinoid fauna consists mainly of immigrants from the Indo-Pacific region that appeared in the Australian sequences from the Pliocene onwards.

Material described herein is lodged in the collections of the National Museum, Victoria (NMV) the Department of Geology, University of Sydney (SU) and the Western Australian Museum, Perth (WAM).

SYSTEMATICS

Order Clypeasteroida A. Agassiz
Family Arachnoididae Duncan

Genus **Fellaster** Durham

Fellaster Durham 1955, pp. 125-126, fig. 29b; Durham 1966, p. U464, fig. 358, 2a-c.

Diagnosis: Petals wide, open and raised. Combed areas cover about two-thirds width of ambulacral plates outside the petals; periproct supra-marginal. Oral surface with two or three post-basicoronal interambulacral plates, and one circlet of interambulacral plates meeting around the small, basicoronal circlet.

Remarks: The genus is separated from *Arachnoides* by the position of the periproct which is more anterior, the absence of a periproctal groove and the extension of two or three

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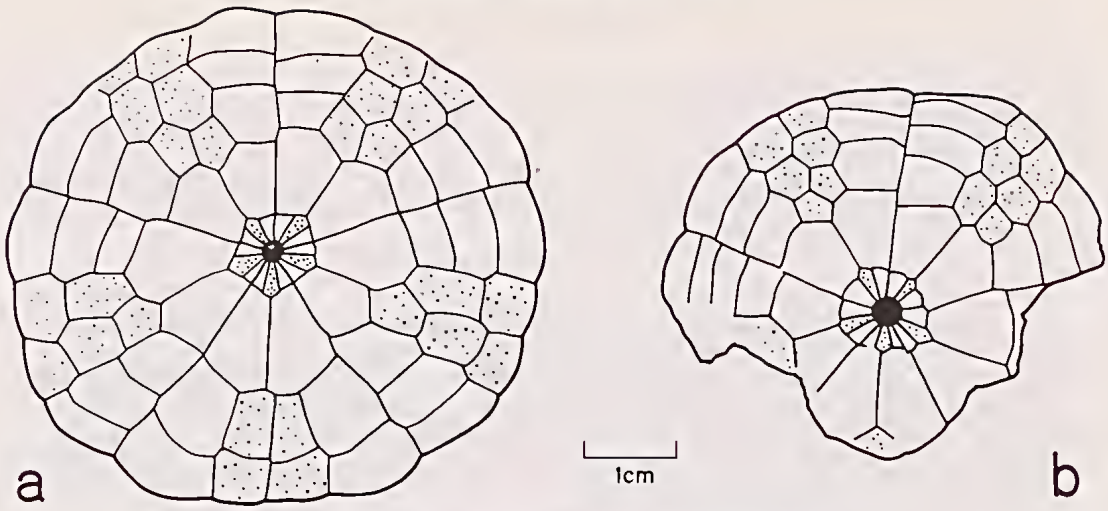


Fig. 1. Plating of adoral surface of *Arachnoides incisa* (Tate). (a) NMV P55478, Red Bluff, early Pliocene; (b) NMV P55480, Werrikoo, Pleistocene.

interambulacral plates onto the oral surface. Previously, the genus has been monotypic and known only from New Zealand in *F. zelandiae* (Gray), a common littoral echinoid. Farquhar (1894) recorded this species as occurring in the Pliocene of Wanganui. However, Fell (1953, p. 254) notes 'A mid-Pliocene New Zealand species much resembles a species still found in Recent Queensland waters', suggesting rather a relationship of this form with *Arachnoides placenta* (Linn.). No material of the New Zealand Pliocene form is at present available for study.

Fellaster incisa (Tate)

(Pl. 20, fig. 4, 6-7; Fig. 1)

Arachnoides incisa Tate 1893, p. 192, pl. 13, fig. 3; H. L. Clark 1946, p. 340.

DIAGNOSIS: A species of *Fellaster* with well defined ambital ambulacral indentations.

MATERIAL AND OCCURRENCE: The holotype, the specimen figured by Tate, is AUGD T359, Red Bluff, Lake Tyers, Gippsland, from the Jemmys Point Formation of Early Pliocene age. A topotype specimen (NMV P55478) is illustrated in Pl. 20, fig. 7; Fig. 1a. The Pleistocene specimens (NMV P55479-554780) are from Allot. 73B, Parish of Werrikoo, "*Bankivia* Beds" (*ex* F. A. Singleton collection).

REMARKS: This species is extremely close to *F. zelandiae*, seeming to differ solely in the presence of ambital indentations. Although the Pleistocene material is fragmentary, one of the specimens shows well this characteristic.

FAMILY LAGANIDAE Desor

Genus **Peronella** Gray

Peronella Gray 1855, p. 13; Mortensen 1948, p. 286 *et seq.*; Durham 1955, pp. 139-141; Durham 1966, pp. U473-475.

Peronella orbicularis (Leske)

(Pl. 20, fig. 1-2, 5)

Echinodiscus orbicularis Leske 1778, p. 208.

Peronella orbicularis (Leske) Mortensen 1948, p. 286 *et seq. (cum synon.).*

DIAGNOSIS: A small low species of *Peronella*, rounded to somewhat angular in outline, with comparatively large pointed petals and with flat or concave oral surface. Margin of the test usually thickened.

MATERIAL AND OCCURRENCE: Forty specimens (WAM 9037/46 and SU F21767-8) from the Carnarvon Basin appear to have been derived from the Exmouth Sandstone, being collected from the eastern margin of Lake McLeod between Red Bluff and Cape Cuvier. The illustrated specimens (SU 13317-9) are from the same general locality. ?Early Pleistocene. In addition there are 12 specimens from various localities in the Roe Calcarenite.

REMARKS: This characteristic species of *Peronella* is at present distributed from the Malaysian region down into tropical Australian waters. According to H. L. Clark (1946) it is found south as far as Cape Upstart, Queensland, and Shark Bay in Western Australia. Mortensen's statement that it occurs as far south as Albany requires verification. It has also been recorded from the upper Miocene of Java although this occurrence is questioned by Mortensen (1948 p. 290).

In specimens from the Carnarvon Basin the test is more fragile and the margin is thinner than in those from the

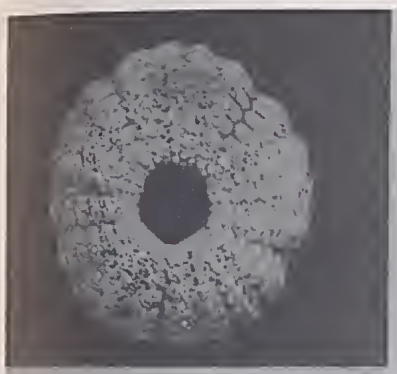
PLATE 19 (*opposite*)

Figures x 2 unless otherwise stated

Fig. 1-3 *Microcyphus annulatus* Mortensen. (1) Adoral view of WAM 69.619; (2) Adapical view of SU 13320; (3) Lateral view of NMV P27037. Various localities from the Roe Calcarenite, W.A., ?Pleistocene.

Fig. 4 *Amblypneustes* sp. nov. Lateral view of WAM 69.693, W. of Eucla, Western Australia, Roe Calcarenite ?Pleistocene.

Fig. 5-7 *Amblypneustes formosus* Valenciennes. (5) Lateral view of naked test from St. Vincent Gulf, S. Australia, showing characteristic colour marking, x3; (6) Lateral view of NMV P27035, Roe Calcarenite, ?Pleistocene; (7) Lateral view of SU F181/70, east of Robe, S.A., ?Pleistocene.



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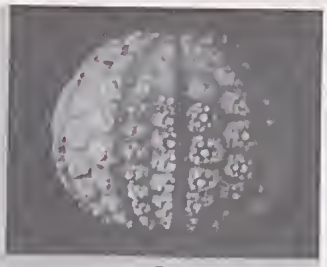

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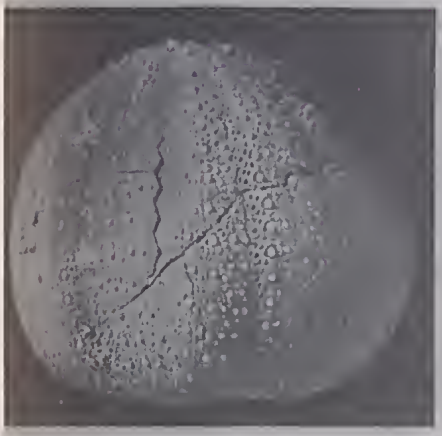

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PLATE 19

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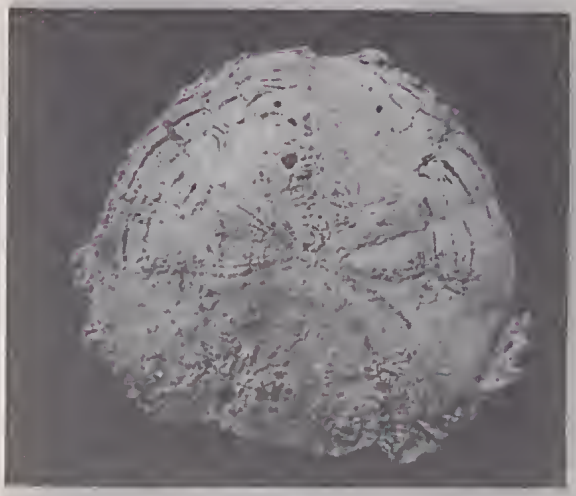

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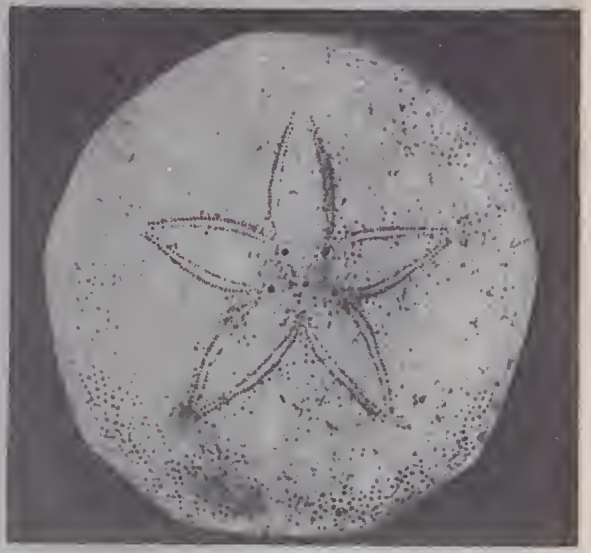

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PLATE 20

Roe Calcarenite Mortensen (1948, p. 288) described similar variation in living material.

Order Camarodonta Jackson
Suborder Temnopleurina Mortensen
Family Temnopleuridae A. Agassiz

Remarks: The abundant Australian Tertiary temnopleurids have been revised by Philip (1969, 1971). Those previously described belong to sculptured temnopleurid genera, mostly confined to Tertiary strata in Australia and New Zealand. However, the occurrence of *Pseudechinus* cf. *albocinctus* (Hutton) in the late Miocene of eastern Victoria (Philip 1969, p. 268) points to the Tertiary origin of this living Australian, New Zealand and S. American genus. In terms of the two-fold division proposed by Philip (1969) for the family, the two genera recognized here are temnopleurids with pitted sutures, and so bear no close relationship to the older Tertiary species.

Genus Amblypneustes L. Agassiz

Amblypneustes L. Agassiz, 1841, p. 7; Mortensen 1943, p. 186 *et seq. (cum. synon.)*.

Diagnosis: Moderate to large-sized temnopleurids with ambulacra somewhat narrower than interambulacra and with one primary tubercle to each compound plate. Pore-pairs of the ambulacra arranged in arcs of three; no widening of the poriferous tract toward the peristome. Primary tubercles faintly crenulated or smooth, similar in size to secondary ones; sutural pores often indistinguishable. Apical system regularly dicyclic; gill slits shallow.

Remarks: This endemic genus contains some of the most characteristic living Australian echinoids. It differs essentially from *Holopneustes* in the structure of the ambulacra which possess a primary tubercle every second or third compound plate. Geographically *Amblypneustes* ranges from Geraldton to Tasmania and Bass Strait. It is a littoral genus, living in abundance on shallow, grassy bottoms. Often after storms it is washed up in great numbers along southern Australian beaches. Fossil occurrences have not been reported previously.

Although *Amblypneustes* may be readily distinguished from the closely related genus *Holopneustes* in the presence of a primary tubercle on each ambulacral plate, test characters in general do not permit differentiation of the several living species currently recognized. They are distinguished by the nature of the periproctal plates (whether smooth or tuberculated), the colour and length of the spines, the nature of internal spicules and colour markings of the test, features not usually preserved in fossil material.

Amblypneustes formosus Valenciennes
(Pl. 19, fig. 5-7)

Amblypneustes formosus Valenciennes 1846; Mortensen 1943, p. 203 *et seq. (cum synon.)*; H. L. Clark 1946, pp. 317-318.

Diagnosis: A species of *Amblypneustes* with moderately large primary and small secondary tubercles; pore-pairs arcuate but never triserial. Primary interambulacral tubercles separated by a lozenge-shaped dark-brown area; ambulacra with similar, although less well-defined, colour markings.

Material: SU F181/70, "Marine" limestone, Section 32, Hundred of Ross, County Robe, approximately 25 km east of Robe, South Australia (?Pleistocene). A second specimen, NMV P27035, from spoil heap, PMG Tower No. 33, 50 km east of Madura, Western Australia, Roe Calcarenite (?Early Pleistocene), is with some slight reservation also referred to this species.

Measurements:

	h.d.	*v.d.*	*ambs*	*inter-ambs*
P27035	43 mm	39 mm	*c.* 44	*c.* 30
SU F181/70	77 mm	72 mm	*c.* 53	*c.* 36
Amblypneustes sp. nov.				
WAM 69.693	26 mm	21 mm	25	22

Remarks: Although traces of original colour markings in fossil echinoids are found rarely (*e.g., Ortholophus woodsi* (Laube), Philip 1969, pl. 8, fig. 16) their occurrence in SAF 181/70 is particularly fortunate, for they permit positive identification of the specimen. Although it is not well preserved as to surface detail, it seems that the white areas in the specimen (Pl. 19, fig. 7) have been preferentially weathered and all traces of staining and surface ornamentation have been removed from them. In contrast, in living specimens, it is these areas that are dark brown in colour. In terms of coloration the fossil specimen is therefore in part a photo-negative of a living specimen (Pl. 19, fig. 5). The lozenge-shaped colour markings of *A. formosus* distinguish its test from other species of *Amblypneustes*, in particular *A. pallidus* Lamarck. Although the specimen from the Roe Plains lacks such characteristic colour markings, it is referred to *A. formosus*.

It should be noted that both of the fossil specimens here identified as *A. formosus* are larger than previously recorded living specimens. H. L. Clark (1946, p. 318) mentioned the largest specimen he encountered as one with h.d. of 36 mm. and v.d. of 37 mm. However, both tests conform to the characters of the living species in all other respects.

Amblypneustes sp. nov.
(Pl. 19, fig. 4)

Diagnosis: A species of *Amblypneustes* with narrow ambulacra and high ambulacral plates with erect arcs. Secondary tubercles small and sparse.

Material: WAM 69.623, 74 km by road west of Eucla

Plate 20 (*opposite*)

Figures x 2 unless otherwise stated

Fig. 1-2, 5 *Peronella orbicularis* (Leske). (1) Adoral surface of SU 13317, a specimen prepared to show sutures, Carnarvon Basin, ?Pleistocene; (2) Adapical surface of SU 13318; (5) Adapical surface of large specimen SU 13319.

Fig. 3 *Microcyphus annulatus* Mortensen. Enlargement of ambital ornament of WAM 69.619, Roe Calcarenite, ?Pleistocene.

Fig. 4, 6-7 *Fellaster incisa* (Tate). (4) Adapical view of NMV P55479, Allot. 73B, Werrikoo, Victoria, Pleistocene, x 1; (6) Adapical view of holotype AUGD T359, Red Bluff, Lake Tyers, Gippsland, Victoria, early Pliocene, x 1; (7) Adapical view of NMV P55478 from the same locality.

Motel, south side of Eyre Highway; WAM 69.693, same locality, north side of Eyre Highway, and four other fragmentary specimens, all from the Roe Calcarenite. (?Early Pleistocene).

REMARKS: This species is distinguished from previously described species of *Amblypneustes* by its high ambulacral plates, and narrow ambulacral columns. In *A. pallidus* and *A. formosus* a specimen of dimensions similar to WAM 69.693 has *c.* 35 ambs in each column as opposed to 25 in this species. The faintly crenulated tubercules, sparsely tuberculated ambulacral and interambulacral midzones with ill-defined sutural pits, together with the shallow gill slits, indicate that the species is best referred to *Amblypneustes*. In terms of existing published information it bears no close relationship to any living Australian species.

Genus Microcyphus L. Agassiz

Microcyphus L. Agassiz 1841, p. 8; Mortensen 1943, p. 148 *et seq. (cum synon.).*

DIAGNOSIS: Small, hemispherical temnopleurids with narrow poriferous tracts and with conspicuous, often sunken median ambulacral and interambulacral zones. Compound ambulacral plates trigeminate, each with a primary ambulacral tubercle. Tubercles smooth or faintly crenulate; apical system regularly dicyclic; gill slits obsolete.

REMARKS: Mortensen (1943) noted that the living southern Australian species *M. zigzag, M. annulatus, M. composus*, and *M. pulchellus* form a separate group, characterised by the high, egg-shaped, thick test. These features readily distinguish the group from other Indo-Pacific species.

Microcyphus annulatus Mortensen
(Pl. 19, fig. 1-3)

Microcyphus annulatus Mortensen 1904, p. 101; 1943, p. 171 *et seq. (cum synon.)*; H. L. Clark 1946, p. 316.

DIAGNOSIS: A high-tested species of *Microcyphus* with upright ambulacral arcs, so that the ambulacra appear uniserial. Median and horizontal sutures conspicuously deepened, with broad, bare, median midzone.

MATERIAL: Five tests: one from 50 km east of Madura; the remainder from a locality 74 km by road west of Eucla Motel, Eyre Highway, all from the Roe Calcarenite. (?Early Pleistocene).

MEASUREMENTS:

	h.d.	*v.d.*	*ambs*	*interambs*	*apical system*	*peristome*
NMV P27037	16.5	14.0	14(15)	11	?4 mm	5 mm
WAM 69.619	19.0	16.5	20(21)	15(16)	4.5 mm	4.7 mm
WAM 70.1825	13.5	12	16(17)	13(14)	*c.*4.5 mm	3.8 mm
WAM 69.692	13	12	17(18)	13	*c.*3.5 mm	4.0 mm
SU 13320	12.0	10.5	14	11(12)	3.5 mm	4.5 mm

REMARKS: This species is charactized particularly by the coloration of the radioles, which have a single broad band of red around the proximal part. Mortensen (1943), in discussing the species *M. pulchellus, M. composus* and *M. annulatus*, gave features such as the number of coronal plates for a given size and the size of the peristome to distinguish their tests. For example, he noted that in *M. annulatus* the peristome is smaller than the apical system. However, for the three species mentioned above, respectively only one, two and three specimens were available to him for study so that the range of variation in test characters is poorly known. The specimens from the Roe Calcarenite show wide variation in test characters and are here regarded as belonging to the one variable species. It seems likely that the living species, when better known, will exhibit similar variation. The specimens are referred to *M. annulatus* essentially on the basis of ambulacral and interambulacral structure and ornament. One specimen (SU 13320), appears to conform closely with the dimensions of the second of Mortensen's (1943, p. 172) specimens, except that the peristome is larger.

ACKNOWLEDGMENT

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